A High Efficiency Cryocooler for In-Space Cryogenic Propellant Storage, Phase I Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

NASA is considering multiple missions involving long-term cryogen storage in space. Liquid hydrogen and liquid oxygen are the typical cryogens as they provide the highest specific impulse of practical chemical propellants. These cryogens are stored at temperatures of nominally 20 K for hydrogen and 90 K for oxygen. Due to the large size of these tanks, refrigeration loads to maintain zero-boil-off are high, on the order of 10's of watts at 20 K and 100's of watts at 90 K. Space cryocoolers have been developed for cooling space sensors that have modest cooling loads and are not suitable for high capacity applications. On this program, we propose to develop a high capacity turbo-Brayton cryocooler that provides 150 W of refrigeration at 90 K. On the Phase I project, we will design the cryocooler, assessing the size, mass, and performance, and assess development risks. On the Phase II project, we will develop and demonstrate a critical cryocooler component. In Phase III, we will build and demonstrate an engineering model cryocooler. Successful completion of this project fills a clear void in space cryocooler technology.

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: Space applications for high-capacity turbo-Brayton cryocoolers include cryogen storage for planetary and extraterrestrial exploration missions, CEVs, extended-life orbital transfer vehicles, long-term geosynchronous missions, in-space propellant depots and extraterrestrial bases, and cooling systems for observation platforms requiring large arrays of infrared and X-ray detectors. Terrestrial applications include cooling for spaceport cryogen storage and transportation systems. The highly reliable and space-proven turbo-Brayton cryocooler is ideal for these missions.

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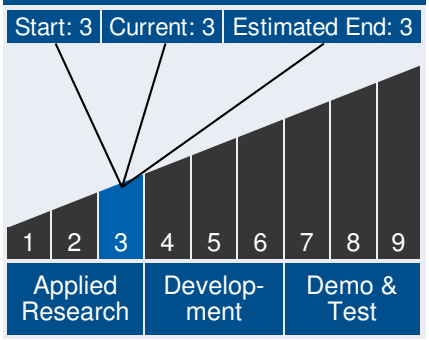
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

Continued on following page.

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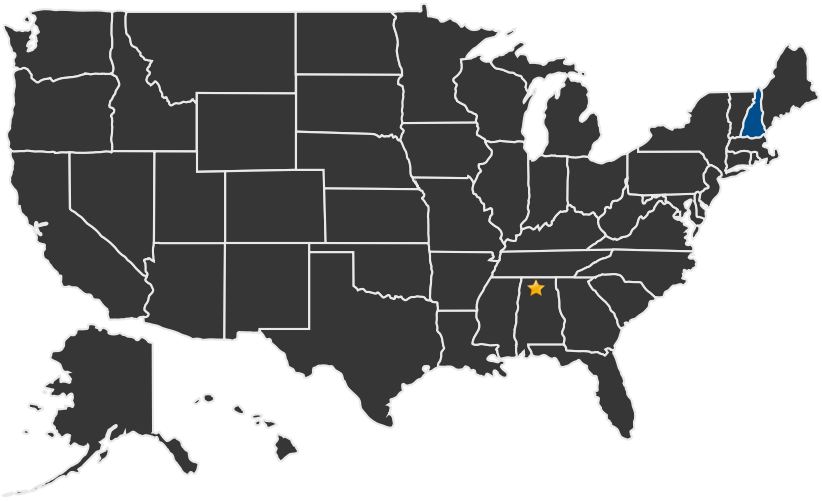
To the commercial space industry:

Potential Non-NASA Commercial Applications: Private sector applications for high-capacity turbo-Brayton cryocoolers include cooling for laboratory- and industrial-scale gas separation, liquefaction, cryogen storage, and cryogen transportation systems; high-temperature superconducting magnets in motors and magnetic resonance imaging systems; liquid hydrogen fuel cell storage for the automotive industry; and commercial orbital transfer vehicles and satellites.

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Marshall Space Flight Center

Other Organizations Performing Work:

- Creare, LLC (Hanover, NH)

PROJECT LIBRARY

Management Team *(cont.)*

Principal Investigator:

- Mark Zagarola

Technology Areas

Primary Technology Area:
In-Space Propulsion Technologies (TA 2)
└ Chemical Propulsion (TA 2.1)
└ Liquid Cryogenic (TA 2.1.2)

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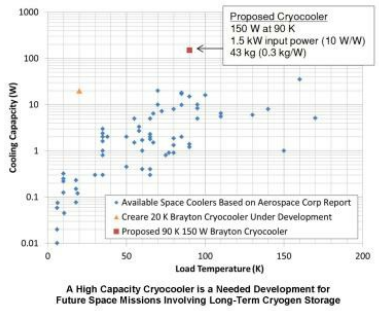
Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23576)

IMAGE GALLERY



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DETAILS FOR TECHNOLOGY 1

Technology Title

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